THE TELEGRAPHIC JOURNAL.

VOL IV.—No. 80.

THE SCIENTIFIC APPARATUS COLLECTION.

THERE can be no doubt that the exhibition of scientific instruments at South Kensington is a success. It has certainly been carefully undertaken, and the officials have evidently had the cordial co-operation of many scientific men, both in England and abroad. And the fact that the space, which was originally supposed sufficient, had to be greatly increased, shows that the originators even under-estimated the importance in which scientific men and instrument makers viewed the proposition. Nor do we think, from what we have seen, that, as some ill-natured writers have suggested, it has degenerated into a mere bazaar of ordinary instruments exhibited for sale. Naturally, instrument makers are commercial men, and the sale of their productions is their *raison d'etre*. But most of those who have risen to position, have done so, in a great degree, by their love of science, a pride in excellency of workmanship, and a desire for invention. Indeed, it is to those who are thus actuated in their business that such comparisons, as a side by side exhibition of their work, is most acceptable. The merely commercial tradesman would seek to make his way more by printed advertisement and exhibition in an ordinary busy thoroughfare.

Instrument makers are not, however, the only exhibitors; educational bodies, professors, engineers, government departments, have lent a willing hand, and some of them have aided the official committee in adding to the collection what may be termed the illustrations of the Archæology of Science. The earliest locomotive, telescope, electrical machine, and microscope, &c., are to be seen, and have a certain amount of interest to those who have a special taste for the particular department in science to which these belong. To the young student the primitive and rough instruments, which have been used by some of the earliest pioneers of science, and which have led to discoveries gradully leading up to those which have almost revolutionized the world, must teach a lesson of patience and perseverance, which no mere lectures could impress so strongly.

Not only to the student but to the professor and professional man is there food for the eye, and the mind, for although most men connected with science read with avidity all that is published and falls in their way as regards inventions and discoveries abroad, it is impossible to see every little paragraph in the numerous technical journals that are now published, and thus, unless a subject is of such importance as to go the round of the scientific press or of a large portion of it, a modest paragraph perhaps containing an important step or novelty in science may escape notice and sink out of sight, perhaps into oblivion, until it is again brought forward by some other person under more favourable circumstances.

Indeed, to recollect even what we have read on some subjects is difficult, and we require at times to see former inventions brought forward to be reminded that they exist.

As an example in point, we would mention the subject of the Count Du Moncel's letter in our present number. Iron-cased magnets have recently formed the subject of a paper before the Society of Telegraph Engineers, and was still more sensationally brought forward previously by Mr. Faulkner, as a novelty at Manchester, and at Mr. L. Clark's conversazione last winter. M. Du Moncel has most assuredly demolished their novelty very completely. There is an illustration of one in his Etude de Magnetisme, published in 1858, a work which most electricians, even in England, possess. Yet the fact passed unnoticed at the discussion at the Telegraph Engineers. Indeed, it is not always easy to recollect what we have read as regards points which establish priority of invention. An appeal to the eye by an actual exhibition of an instrument is liable, we believe, to engrave the subject on the memory more than merely reading of it in a book, and we venture to assert that any novelty in the present exhibition will not be easily forgotten.

A permanent museum is, however, that which is required where instruments and inventions may remain to be seen from time to time. Of course we do not assert that such a museum would at once settle all points of priority, since every inventor could not afford to send a sample of his invention or improvement, and the state would not always purchase them. But still many would find their way there. For those having instruments or samples of manufacture which had become of mere archæological interest, would gladly send them to any public depository where they would be safe from destruction. And even drawings of instruments might be there placed. Thus an inventor, who being too poor to take out a patent, might at a small expense at least secure for himself whatever honour was due to him.

An occasional visit to such a museum, if carefully arranged and catalogued yearly, would certainly refresh our memory, if not our knowledge, as to what had been previously done in any par-

ticular branch, and even if, for example, we did not find the first iron-cased magnet made, we should be very likely to find some of those numerous examples mentioned by M. Du Moncel. By such means it would be possible to bring honour to those to whom it was due, perhaps a little nearer than is sometimes now the case. Only within the last six years (as mentioned in our notes to-day) it has become known that the first observation of the deflection of a magnetic needle by the electric current was discovered and published by two Italian philosophers, twenty years before Oerstedt made the same discovery, although the latter has always had the honour of the discovery.

EFFECT OF ELECTRICITY ON PARTICLES SUSPENDED IN LIQUIDS.

Some interesting observations on this subject have recently been described by M. Holtz in *Poggendorff's Annalen*. A "wandering" of particles suspended in a liquid, when submitted to electric currents, has long been known of, and was fully studied by M. Quincke. M. Holtz finds that in all cases of such motion, there is at the same time a clinging of particles to one of the poles, and this often with such precision that one might construct an electroscope on this principle for ascertaining the polarity. Especially notable is the tendency of *Semen Lycopodii* in insulating liquids, particularly sulphuric ether, to cover the negative pole with a thick coating, while sulphur, cinnabar or sulphide of antimony in the same liquid, only coat the positive pole. A simple medicine glass even suffices for the experiment, a conductor or half conductor being introduced through the stopper. The glass is held in the hand, and the conductor brought to an electric machine; the phenomenon then occurs. It is more suitable, of course, to have the bottom perforated for insertion of the second pole, or to use an open glass with the two poles pushed down into it. Either a frictional or influence machine may be used.

M. Holtz did not, like Iürgensen and Quincke, use capillary tubes, but wide vessels, and this, he thinks, may be the reason why many substances, *e.g.* sand, manganese, sugar, &c., seemed to be quite indifferent, neither wandering nor adhering to the poles. But here occurred another interesting phenomenon, if the bottom of the vessel were straight and smooth, and not rendered conducting by a layer of moisture condensed from the air. For the particles formed figures, under the action of the electric current, of very various character according to their size and structure, and according to their own conductivity or that of the liquid. Figures of extraordinary fineness and regularity, and quite corresponding to those assumed by iron filings under action of the magnetic poles, were obtained with finely pulverized manganese, emery, and oxide of iron, in petroleum, oil of turpentine, benzine, and sulphuric ether. Still finer, and consisting of largely entwined lines, were the figures from reduced iron; but extremely little of this substance must be used, owing to its great conductivity. The figures formed of sawdust were more regular, and branching like trees. Cinnabar in ether gave a cloud-like form which, on account of the polarity referred to, surrounded the positive pole. Sugar and bran mostly formed thick connected skeins, through which the electricity then flowed as by a conducting bridge.

In very few cases, however, is the figure stable during the electric action. In general, while the figure does not essentially alter in character, one may readily distinguish in it a double movement, first a thrusting to and fro of the separate particles within the lines they form (and this motion is stronger the larger the particles and the smoother their surface); then a continuous displacement of entire lines vertically to the connecting line of the poles, and this apparently more outwards if the electric current is strong, more inwards if it is weak. This latter motion, however, frequently becomes of a rotatory character, the connecting lines sometimes breaking, and each part for itself tending to circle round the pole to which it adheres. Such circular motion occurs in greater measure with cinnabar, sulphide of antimony, and some other matters, which generally do not form connected lines. It appears in a peculiar balling together and gliding forward of separate parts.

But the circulur movement is greatly favoured if a wire ring be taken for one pole, and the other pole be placed in the centre of it. In this case, naturally, the external form of the figures is altered, and in most instances, whatever the polarity of the central conductor, one obtains figures which in their radiating structure resemble the Lichtenberg figures. With those materials which do not form connected lines, the circular motion now becomes so distinctly the prevailing one, that the figures produced fully correspond to the negative Lichtenberg figures.

The rotation-phenomenon was best obtained in a glass 200mm. high and 100mm. diameter, having a perfectly even and smooth bottom, and which had not been used for previous experiments. In the axis was fixed a wire which, with its lower point, touched the middle of the bottom, and (the glass itself standing on a conducting base) was slowly and constantly electrified with one pole of an influence machine. M. Holtz describes in detail the effects obtained when this vessel was charged after the fashion of a Leyden jar.

Another not uninteresting phenomenon in some of the above experiments was the cone-shaped rise of the liquid on the immersed wires. This takes place to greatest degree on the negative pole, and with sulphuric ether. It is intimately connected with the polarity of the suspended particles, for through adhesion of these to the one pole the rise of the liquid on the other pole is favoured. M. Holtz hopes to study the phenomenon further.

CLAMOND'S THERMO-ELECTRIC BATTERY.*

By LATIMER CLARK, C.E.

A difference of potential in thermo-electricity is produced whenever two dissimilar metals are brought into contact and heated at their point of junction. If the further or cool extremities are

* A paper read before the Society of Telegraph Engineers.

brought together, or connected by means of a wire, a thermo-electric current passes, which will continue to flow so long as a difference of temperature is maintained. The metals which have recently been employed to produce this effect are antimony and bismuth, because they exhibit this property to a very marked degree. Other metals or alloys may, however, be used with equal or even to greater advantage.

Markus, in Germany, devised, in 1865, a very powerful thermo-electric battery, whose positive elements consists of 10 parts of copper, 6 of zinc, and 6 of nickel; the negative elements being composed of 12 parts antimony, 5 zinc, and 5 bismuth; while in another form of the battery he employed as the positive metal, 65 parts copper and 31 zinc, and for the negative 12 parts antimony and 5 zinc or German silver. (The terms positive and negative are employed in the same sense as in the ordinary galvanic battery, the positive metal being that from which the current is conventionally understood to start and pass through the liquid).

Professor Dove employed iron and platinum soldered together in alternate lengths, the whole being wound on a cylinder of such diameter that the platinum-iron junctions were all on one side of the cylinder, and all the iron-platinum junctions on the other.

Farmer, in America, used Markus metal and German silver, but failed to secure a good permanent connection.

Thermo-electric piles of iron and German silver have been built up, and are very efficient. Yet no fewer than 700 of these elements are required to give an electro-motive force equivalent to a single Volt.

Clamond in his first thermo-pile employed a sulphide of lead in the form of native galena and iron. This he was subsequently led to abandon in favour of his present system.

Various other forms in addition to those mentioned have, from time to time, been brought forward by different experimenters, but almost the only practical application of them which had until recently been attended with any beneficial results was that made by Melloni and Nobili in their masterly investigation of radiant heat. By them the thermo-electric piles were employed as thermometers, and they still form by far the most delicate means of measuring minute differences of temperature; so sensible, in fact, are they, that by means of them the heat of even the fixed stars has been rendered sensible.

The Thermo-Electric Generator Company was formed in 1874 for the purpose of working Clamond's patents; their Paris offices are at 86, Boulevard de Courcelles, and their London factory at 27, New Street, Cloth Fair. The French Government extensively employ the thermo piles manufactured by them; and they are also adopted in the electro-plating houses of Goupil, Christafle, and others.

The latest form of pair employed by Clamond consists of an alloy of two parts of antimony and one of zinc, as the negative metal, and ordinary tinned sheet-iron as the positive element—the current flowing at the heated junction from the iron to the alloy. The alloy is in the form of a flat bar, broader in the middle than at the ends, and measuring 2 to 2¾ inches in length, by ⅜ths of an inch to 1 inch in thickness. The sheet-iron, after being stamped out, is fixed in a mould into which the melted alloy is poured; before the alloy has cooled the mould is opened and the bars are removed. The alloy melts at a temperature of 500° F, and expands considerably in cooling; the more frequently it is recast the more perfect does the mixture become, so that old piles can be reconverted with advantage. The alloy is very weak and brittle, and can be broken almost as easily as loaf sugar.

The bars are arranged in a radial manner round a temporary brass cylinder, a thin slip of mica being inserted between the tin lug and the alloy to prevent contact, except at the junction. The number of radial bars varies with the size of the pile: eight or ten are generally used. The bars are secured in their position by a cement formed of powdered asbestos and soluble glass, or solution of silicate of potass. As soon as one circle of bars is completed, a ring of dry asbestos is placed upon it, and over this another circle of elements is built, and so on until the whole pile is completed. The entire structure is consolidated by means of cast-iron frames placed at the top and bottom, and drawn together by screws or rods. The inner face of each element is protected from excessive heat by a tin strip, or cap of tin bent round it before it is imbedded in the cement: the projecting strips of tin from the opposite ends of each pair of elements are brought together and soldered with soft solder by means of the blow-pipe. The positive poles are always placed at the top.

The pile is heated by gas mixed with air, on the Bunsen arrangement, that is to say, the tube up which the gas passes is pierced with a number of small holes, and these approximately correspond in position, as well as number, with the elements employed. Through an orifice in the gas supply tube, a regulated proportion of air passes, and this mixes with the gas before entering the tube forming the chimney. Through the small holes the mixture escapes, and in the annular space between the tube and the elements, it burns in small blue jets, the products of combustion being carried off at the top. When combustion is going on properly, the earthenware tube glows with a dull-cherry red colour, and none of the jets should impinge on the elements. By means of an excess of gas, the pile may be overheated and the connections of the elements destroyed; when in good order, the temperature of the inner bars should be about 400° F., and that of the outer about 200° F.

To prevent, as far as possible, injury from overheating, and at the same time to lessen the consumption of gas, Clamond has recently introduced a new form of pile, from which he derives considerable advantages. The mixture of gas and air is still burnt as before in the earthenware tube; but this, in place of extending up the whole height of the battery, is carried up to only about half its height. The earthenware tube in the new arrangement is surrounded by an iron tube of greater diameter, which is carried up almost to the top of the battery, and is open at the top. The elements are placed in the usual way outside the iron tube, and from the bottom of the annular space intervening a chimney leads off. The top of the pile is covered over by a closely fitting moveable cover. The air enters at the bottom of the iron tube and

the heated gases pass upwards to the top; finding no means of escape there, they curl over, and descending outside the iron tube, *i.e.*, between it and the elements, they finally make their exit by means of the chimney already referred to. The elements are thus heated partly by radiation from the iron tube and partly by the heated gases on their way downwards to the chimney. Not only is the danger arising from the gas jets impinging on the elements thus removed, but the consumption of gas is said to be reduced by one-half. Should a bad connection occur, it is short-circuited by a piece of wire, and a defective element can readily be cut and replaced by a sound one.

A small gas regulator (to keep the pressure of gas, as far as may be, constant) is employed with each machine. The consumption of gas in small-sized elements is stated to be about one foot per hour for each volt of tension. Where gas is not available for heating purposes, coke or charcoal is found to answer very well. Paraffin oil might probably be employed with advantage, although thus far it does not seem to have been successfully used as a source of heat in the thermo-piles.

Iron screens are sometimes employed to surround the pile, their object being to cool the external surfaces of the elements by causing a current of cold air to pass over them. They likewise prevent, to some extent, the fracture of the bars which takes place if the pile cools too rapidly. The subject of screens and other mechanical appliances for cooling the external surfaces of the thermo-electric elements, such as currents of air, the use of water, evaporation of moist surfaces, &c., have thus far been imperfectly investigated, and throw open a wide field for research, notwithstanding the labours of M. Clamond.

The electro-motive force of a thermo-electric element, such as those employed in Clamond's pile, is such that 20 elements may practically be regarded as equivalent to one Daniell's cell in this respect, that is, they give about one volt.

The following table, published by the Thermo-Electric Generator Company, and found by experiments conducted by the author to be very correctly stated, gives the electro-motive force, internal resistance,* and consumption of gas for the piles usually manufactured by them:—

	Size.	Electromotive force.	Internal resistance.	Consumption of gas. (Approximate cubic feet.)
For tension	40 bars	2 volts	1·0 ohms	—
	60 „	3 „	1·5 „	3
	120 „	6 „	3·0 „	5
	150 „	7 „	3·75 „	6
	240 „	12 „	6·0 „	9
	380 „	19 „	6·75 „	23
	680 „	34 „	12·25 „	37
For quantity	50 „	2·5 „	·25 „	6
	60 „	3 „	·6 „	6
	100 „	5 „	1·0 „	9
	200 „	10 „	2·0 „	23
	400 „	20 „	4·0 „	37

* The resistance is that of the piles in their hot state; when they are cold it rises about 25 per cent.

COKE-PILES.

For tension	340 bars	17 volts	5·75 ohms	1·5 lbs.
	680 „	34 „	12·25 „	2·0 „
For quantity	190 „	10 „	2·0 „	1·5 „
	400 „	20 „	4·0 „	2·0 „

CHARCOAL PILE.

For tension	100 bars	5·0 volts	1·0 ohms	·33 lbs.
	190 „	8·5 „	3·4 „	·50 „
For quantity	60 „	3·0 „	·6 „	·33 „
	100 „	5·0 „	1·0 „	·50 „

The following, extracted from the circular published by the company, give some of the prices which are charged:—

For the tension or small-sized bars:—

2 volts	... £3 0 0	...	40 bars.
3 „	... 4 0 0	...	60 „
6 „	... 6 10 0	...	120 „
12 „	... 13 0 0	...	340 „
34 „	... 32 0 0	...	680 „

For the quantity or large-sized bars:—

3 volts	... £8 0 0	...	60 bars.
10 „	... 20 0 0	...	200 „
20 „	... 32 0 0	...	400 „

The coke-piles are charged as follows:—

		£ s. d.		
10 volts	(quantity)	20 0 0	...	190 bars.
20 „	„	32 0 0	...	400 „
17 „	(tension)	20 0 0	...	340 „
34 „	„	32 0 0	...	680 „

It is found that the electro-motive force of the several layers of elements varies, owing to the fact that some are more fully exposed to the heat than others. The middle layers seem to give the best results, although when first heated the upper bars are stated to give the greater electro-motive force.

So extremely sensitive are the thermo-electric piles, that it is all but impossible to find one in such a state of equilibrium as to give no evidence of a current. If it be so, the passing of the hand into the interior of it, breathing upon it, or even the approach of the body, immediately sets up an action; and whilst they are at work, the effect of a distant fire, or the opening of a window, will produce a sensible effect upon them. When two or more piles, therefore, are employed, they should, in order to secure the best working, be kept as far apart as possible, and allowed free radiation.

Electro deposition is one of the many uses to which thermo-electric piles may be turned, and they are already largely employed for electro-plating. As an instance of what has been done, a battery of 375 elements (whose internal resistance was 4·5 ohms, and electromotive force 14·6 volts) deposited about 180 grains of copper per hour, but then the electromotive force was sufficient to have created a similar deposit in several successive cells, so that no practical results have yet been made known which could be accepted as a theoretical possibility of the work to be effected by them in this respect.

The mechanical power obtained from thermo-piles by electro-magnetic engines has not yet been put to any practical use, nor can it be looked for as ever likely to be worked from an economical

point of view. The electric light furnished by them is powerful and constant, but a very large number of elements has to be employed in order to secure this.

For laboratory use they are very handy, and by utilising the waste heat of kitchen fires they might doubtless be employed to considerable advantage for domestic purposes.

SPECIAL LOAN COLLECTION OF SCIENTIFIC APPARATUS.

THE Special Loan Collection of Scientific Apparatus at South Kensington, which was opened the other day by Her Majesty, and is now opened to the public, is certainly, without exception, the most interesting exhibition of apparatus of a scientific nature ever placed at one time before the public. It is not only from the ordinary scientific point of view that it becomes interesting, but also from the truly historical view, for here we see side by side with the complete instrument of the present day, the germs or seeds, which have gradually been ripening until the full fruit has appeared.

The idea of holding an exhibition of apparatus on loan, was due to some of the authorities at South Kensington originally; it was subsequently brought in a practical form before the Lords of the Committee of Council on Education; they, on the 22nd January, 1875, approved of the proposal to form a loan collection of scientific apparatus, "which was to include not only apparatus for teaching and for investigation, but also such as possessed historic interest on account of the person by whom, or the researches in which it had been employed."

The leading men of science of the country, the presidents of the learned societies, and others, were invited to act as a committee to consider the matter, and aid the Council with their advice.

The result of this was an energetic acquiescence on the part of those invited, and after many meetings, a scheme of classification was submitted and approved with some slight modification. This classification was as follows :—arithmetic, geometry, measurement, kinematics, statics and dynamics, molecular physics, sound, light, heat, magnetism, electricity, astronomy, applied mechanics, chemistry, meteorology, geography, geology and mining, mineralogy, crystallography, biology, &c., the instruments and apparatus to be there employed in teaching, and in the investigation and observation connected with the various sciences.

As soon, therefore, as the programme had been definitely settled, steps were taken to interest foreign countries in the exhibition, and it was determined to obtain the co-operation of men of science on the Continent. These steps were met with the most encouraging results, and favourable answers were received from all quarters. The list of names of those abroad who interested themselves in furthering the objects of the exhibition is a most extensive one, and comprises the names of men well known in the scientific world.

Special arrangements were made for organising and arranging the collection, which was rendered the more difficult in consequence of the limited time left for the purpose, and many gentlemen connected with science volunteered their aid to assist the staff of the Museum in their laborious duties; through this reinforcement and the renewed energies of the staff, the Exhibition was put well together, and the opening day showed it in a very complete form, leaving but little to be done beyond the complete description and numbering of the apparatus.

In addition to the ordinary catalogue, the Council on Education obtained the services of numerous well-known gentlemen of science for writing a handbook containing introductory notices to the several sections. This handbook will be found most interesting to the visitor, and should be perused with care. Whilst the catalogue gives a list and description of the various apparatus, the handbook forms a general guide to the various sciences. Whilst not dealing with the instruments in particular, the descriptions refer to the science in general.

It was originally intended to exhibit the collection in the South Kensington Museum, but through unforeseen circumstances the plan had to be abandoned. Fortunately the Western Annexe of the Exhibition building was available, and the collection has been placed there, occupying the whole of the galleries on the western side of the Horticultural Gardens.

The arrangements are as follows:—On the ground floor the rooms are appropriated to

A.—Educational Collections.
B.—Applied Mechanics.
C.—Ditto.
D.—Naval Architecture and Marine Engineering.
E.—Lighthouse Apparatus.
F.—Magnetism and Electricity.
G.—Arithmetic and Geometry.
H.—Measurement.
K.—Ditto.
L.—Astromony and Meteorology.

On the upper floor

M.—Geography, Geology, and Mining.
N.—Biology.
O.—Conference Room.
P.—Chemistry.
Q.—Light, Heat, Sound, and Molecular Physics.

The whole collection is well worthy of many visits, and a close examination into the details of the various apparatus, but the rendering an account of the total exhibition, would, however interesting it might be, prove far beyond our limits. We propose, therefore, in our next succeeding numbers to deal with those sections which are professionally more associated with the interest of our readers, and as the section of magnetism and electricity contains a more varied and interestingly historical collection than has ever been brought together before, we trust that matter of great importance and of scientific advantage, may be brought before those readers who will be unable to attend and examine for themselves.

MESSRS. B. and J. EDWARDS and Co., the well known photographers, have sent us some specimens of their photo-tint reproduction of photographs. They are charming in delicacy gradation, and the process is evidently well suited for the illustration of books and scientific catalogues.

ON VOLTAIC ELECTRICITY.

By PROFESSOR TYNDALL, D.C.L., LL.D., F.R.S.

(Continued from page 145.)

LECTURE II.

PROFESSOR TYNDALL commenced by saying:—One of my objects in this course of lectures is to give some notion of the manner in which the subject of Voltaic electricity has grown up from its earliest germs to its present wonderful proportions. I therefore, in the last lecture, sought to connect the first observation of Galvini with the previous researches of Lord Mahon. We then passed on to the second discovery of Galvani, and to the celebrated strife arising from it between Galvani and Volta, which ended in the discovery of the pile.

This, as we shall afterwards learn, was not the only battle fought upon this ground. But the battles of science have this to be urged in their favour, that they have always ended by extending the intellectual territory of man, and by rendering him more and more ruler of external nature.

No sooner was the pile discovered than the science of Europe, powerfully attracted, precipitated itself upon this discovery; and the very year the pile was described by its inventor, the decomposition of water was effected.

The two ends of a voltaic pile or of any form of voltaic battery are, when insulated, in opposite electrical conditions. Thus, the platinum end shows positive, while the zinc end shows negative electricity. Volta supposed this current to arise from the *contact* of dissimilar metals. By means of Thomson's quadrant electrometer, the attractions and repulsions of the electricities produced by contact of plates of dry zinc and copper, were rendered plainly visible. Connecting one end of a crown of cups with the earth, the gradual augmentation of electric tension (potential) from this end to the insulated end, was shown by the same instrument.

Hotly upon the discovery of the decomposition of water, followed in the same year (1800), the researches of Cruikshank, by which is was shown that the current possessed the power of separating the metals from their salts in solution. The crystallization of lead by the electrolytic decomposition was first shown by Cruikshank. When the current from a pile of zinc and silver was sent between two wires, plunged in a solution of acetate of lead, "after a minute or two some fine metallic needles were perceived at the extremity of the wire connected with the silver. These soon increased and assumed the form of a feather. The lead thus precipitated was perfectly in its metallic state, and very brilliant."

Cruikshank also experimented with the sulphate of copper with the same result, "the copper being precipitated in its metallic form by the wire connected with the silver," and of the battery. "The most beautiful precipitate, however, was that of silver from its solution in nitrous acid. In this case the metal shot into fine needle-like crystals, articulated or joined to each other as in the arbor Diana."

A voltaic current produces chemical action at a distance from its source. By means of a very handy apparatus, designed by Mr. Cottrell, the oxygen and hydrogen derived from the decomposition of water were collected separately and their properties shown. Two clean platinum plates, connected by wires with the two ends of a voltaic battery, were plunged into a solution of sulphate of copper. Cruikshank's effect was rendered immediately visible, the plate connected with the negative end of the battery being immediately coated with metallic copper, while the other plate remained untarnished. On reversing the current, the coating of copper was rapidly dissolved, the metal being precipitated upon the opposite plate. When a copper wire was connected with the positive end of the battery it was dissolved. This solution of the metal rendered the liquid adjacent to it more dense, and convective currents of the denser liquid became visible when the image of the glass cell containing the electrodes and solution was shown on the screen. Meantime metallic copper was deposited on the opposite side. When with a similar cell the same experiment was made with acetate of lead, beautiful fronds of the crystallized metal sprouted from the negative wire. This experiment was made with Volta's crown of cups.

The decomposition of potash and soda by the voltaic currents (Davy's great discovery in the Royal Institution laboratory), was also shown. In both cases the negative electrode was a rod of coke, the positive a nail. The potash and soda were first melted, in this state they conduct electricity; when solid, they are non-conductors. Potassium and sodium are liberated on the coke and readily ignited by bringing the nail into suitable contact with it, and burnt with their characteristic flames.

The minds of scientific men had for some time been occupied with the thought of a possible connection between the pile and the magnetic needle, but no examination of the free ends of the pile revealed any action. Œrsted quotes the following remark to show that in 1813, his attention was directed to the subject. "It must be determined whether electricity in its most latent state has any action on the magnet as such."

In this vague state the subject rested till the early part of 1820, when Œrsted, surrounded by a number of auditors, tried the effect upon a magnetic needle of a platinum wire raised to incandescence by the current. "Although," he says, "the effect was unquestionable, it appeared to me nevertheless so confused, that I deferred a minute examination of it to a period at which I hoped for more leisure." Early in July, 1820, he resumed the investigation. This was illustrated by Dr. Tyndall:—A copper wire from one end of a voltaic battery was carried along a series of supports, and caused to return along a second set of supports parallel to the first, to the other end of the battery. The wire being placed in the magnetic meridian, a long magnetic needle was placed beneath it. There was no action as long as there was no current, but in the passage of the current the needle was deflected, and took up a permanent position oblique to the magnetic meridian. On placing the needle under the returning wire, the deflection was in an opposite direction. When, moreover, the direction of the current was reversed, the deflection of the needle was also reversed. The direction of the deflection was thus proved to depend on the direction of the current.

Ampére presented a figure to the mind which enables it in all cases readily to follow these motions, and indeed to protect them. Let a little swimmer be imagined on the current, swimming

along with it, and with his face turned on the needle; the north pole of the needle will always be deflected towards such swimmer's left hand. In the return wire the swimmer's arms would occupy positions the reverse of those which they occupied in the outward-bound current; hence the reversal of the deflection must follow.

It is obvious that Œrsted's discovery enables us to infer from the direction of the current the deflection of the needle, and from the deflection of the needle the direction of the current.

Notes.

THE estimated traffic receipts of the West India and Panama Telegraph Company (Limited) amounted in March to £5,006, as compared with £4,705 actual receipts for the corresponding period of 1875.

The traffic receipts of the Eastern Extension, Australasia, and China Telegraph Company (Limited) for the month of April, 1876, amounted to £8,204 against £18,413 for April, 1875. The Madras Penang cable was interrupted all last month.

A petition to wind-up the Electric Power Company (Limited) has been presented to the High Court of Justice.

The Prince Edward's Island telegraph cable is broken, and all telegraphic communication with the island is suspended.

A Brownsville (Texas) despatch, dated April 23rd, states that the telegraph lines in Mexico are down, and business with the interior is entirely suspended.—*Journal of the Telegraph.*

The average time which messages for India, via Teheran, by the Indo-European Telegraph Company, have occupied in transit during the month of April, has been, from Calcutta 32 minutes, Bombay 33 minutes, and other places in India 53 minutes.

The following, from the *Journal of the Telegraph* gives further information regarding the repair of the Havana and Key West 1869 cable in the s.s. *Professor Morse*. This is, we believe, the first repair executed by an American staff in a sea cable, and appears to do them great credit.

The party reached Havana on April 4th, and left on the 5th, in small boats, for Cojimar, where the cable lands. Tests located the fault at 1.3 knots from the shore. Attempts were at once made to raise the cable by underrunning with the small boats, but it was not until the afternoon of the 6th that the junction of the shore end with the intermediate was brought on board. The cable was cut at this joint owing to its unfavourable appearance, but as the tests showed the wire shoreward to be in perfect condition, it was rejointed. To facilitate the work it was here deemed advisable to procure a light schooner, which having been done on the 8th, underrunning was resumed, and at 1 p.m., a galvanometer on shore indicated that the fault had been brought up. This fact was signalled to the working party. The cable was cut and found to be perfect westward by tests with Key West. On the 9th connection was made with new cable on the *Morse*, and the steamer payed out to the point where the cut was made on the 7th, where the final splice was made. After completing the repairs the entire cable was tested for conductivity and insulation, and found to be in excellent condition, as shown by the following figures. Copper resistance per knot, 11.28 ohms. Dielectric resistance, after one minute's electrification, 339.8 megohms per knot.

It appears from the *Bulletino Telegrafico* of Florence that Mr. Stearns, in a letter to the Commander D'Amico, Director-General of Italian Telegraphs, informs him that he has found that to Italy is due the discovery of electro-magnetism, as well as the honour of having made the first Voltaic battery. The facts on which this is based are mentioned in Mr. Sabine's "History and Progress of the Electric Telegraph." It appears that the effect of a current acting on a magnetic needle is mentioned by Professor Izarn, in his "Manuel du Galvanisme" (published at Paris, in 1804) as observed by Romagnosi, a physicist of Trent, and that I. Mojon, a learned chemist of Genoa, stated that non-magnetized needles obtained "a kind of polarity" when submitted to the action of a current. The *Bulletino Telegrafico*, in mentioning this, observes that they thank Mr. Stearns, as they truly believe that the observations of Mojon are little known. Not so in the case of the illustrious Romagnosi, who was not from Trent, but from Salsomaggiore, near Piacenza. It is true it was at Trent that he made his discovery of the deviation of the needle by the electric current. The fact is fully recorded in an epitaph by Pietro Giordani, at the College Alberoni, near Piacenza. It states that the deviation of the magnetic needle by a galvanic current was noticed and published by him in 1802. In the book in question the name is spelt Romagnesi, whereas it should be Romagnosi.

Nature for the 18th of May, has a very interesting account of the Greenwich time-signal system. The mean solar standard clock is a Shepherd's electric clock, and works several other clocks in the various rooms in the building, and also controls clocks in London. The Greenwich time-ball is dropped by electrical action, and hourly currents are sent to the General Post-office and to the Lon.

don Bridge Station, from whence, by other mechanism, the time is distributed to other towns.

The Journal of the Franklin Institute for April, has an article by Professors Edwin J. Houston and Professor Elihu Thompson, on "the Alleged Etheric Force; Test Experiments as to its identity with Induced Electricity." The authors, after showing by experiments, that the so-called force has polarity, conclude by hoping "that the foregoing experiments will have established still more decidedly the fact that all the manipulations classed as 'etheric,' are due solely to inverse currents of induced electricity."

M. Weyprecht, the chief of the second Austrian expedition to the North Pole, has reported on the relation between the Aurora Borealis and the magnetic perturbations. He states that he found, in regions where the aurora exhibited its maximum power, the deviation of the magnetic needle was towards the east. The declination diminished, but always the inclination increased.—*Athenæum.*

The creditable little handbook to the special loan collection of scientific apparatus at South Kensington is well worth perusal. The chapters on Magnetic and Electrical Apparatus are by Professor G. Carey Foster, which is a sufficient guarantee for the excellence of this portion of the work.

The *Philosophical Magazine* has an article on the Determination of the Longitude of Cairo from Greenwich by the exchange of Telegraph signals, by Captain C. Orde Brown. The actual experiments were between Porthcurnow and Alexandria, the whole series of cables being joined direct. The total length of cable was 3,222 nautical miles. 40 Menotti cells were used, although signals were read with 12 cells. The mean loss of time before the signal on make of current was visible, was 1·34 seconds, and that before break of current signal was 1·28 seconds, the mean being 1·31 seconds.

Professor A. Graham Bell has just obtained a patent from Washington for a new method of telegraphy, by mean of an *undulatory* instead of an *intermittent* current, as employed under the former patent. Our readers will remember that during last summer Professor A. C. Bell gave, at the office of the Dominion Telegraph Company in Brantford, an exposition of his telegraphic discoveries; since then, considerable advance has been made in the improvement of apparatus, and some of the results now obtained are very striking; thus, from an electro-magnet at one end of a single wire are heard issuing the sounds of the human voice—tones and words which were spoken or sung before a membrane connected with an electro-magnet at the other end of the wire. Professor A. G. Bell's inventions, secured by patents, include—Simultaneous transmission of a multiplicity of messages, in either direction, on a single wire; the conveyance of autographic messages in *fac simile*; the transmission of vocal or other sounds. The discoveries made by Professor Bell's researches are very startling, and when carried into practical effect will work quite a change in the telegraphic system. To carry the sound of the human voice over the mystic wire is an accomplishment never before scarcely dreamed of! Professor Bell's labours with visible speech, and the success which has accompanied his efforts to make a practical use of it with the deaf mutes in Boston, have already given him an enviable reputation, although his father—Professor A. M. Bell, of Tutelah Heights—may be credited with the discovery of it.—*The Daily Expositor*, Brantford, Ontario, Can.

Despatches have been received at the Navy Department from Captain J. N. Miller, commanding the United States Steamer *Tuscarora*, dated Brisbane Roads, Australia, February 14th, 1876, in which he reports his arrival on the 10th of that month, having left the Fiji Islands on the 25th of January. The *Tuscarora* was sent out to make soundings between Honolulu and Brisbane, with the view of learning the practicability of laying a submarine cable between those points. One hundred and seven casts were made in all. Captain Miller says that as far as the nature of the bottom and the depth of the water are concerned, the entire route between Honolulu and Brisbane, *via* the Phœnix Islands and the Fiji Islands, is an easy and practicable one for laying a submarine cable. The citizens of Brisbane showed great interest in the work, and especially in the *Tuscarora*, as it was the first time that an American man of war ever visited that port. The *Tuscarora* left Sidney for home March 11th, *via* Honolulu and the Samoan Islands.—*Journal of the Telegraph.*

The Dawn of Light.—The invention of the electric telegraph was recognized in the Pekin *Gazette* for the first time on March 4th. It is spoken of in connection with the riots at Foo Chow during the attempt to establish a line between Foo Chow and Amoy.—*Journal of the Telegraph.*

The money Article of the *Times* of May 25, mentions a brochure on the Telegraphs of Belgium by Mr. Vinchent, the Belgian Inspector General of Posts and Telegraphs. According to this authority Belgium possesses 4,958 kilometers of telegraphic lines, on which are stretched 21,093 kilometers of wire, exclusive of 991 kilometers erected at the expense of the concessionaires of the conceded railways. There are 586 offices. The Morse instrument is employed, except at the

principal towns, such as Brussels, Ghent, Liege, and Ostend, where the Hughes instrument is employed. The net revenue is about 290,000 francs, without taking into account the charges on capital expended on construction.

The Western Union Telegraph Company are laying down two pneumatic tubes and underground wires in New York, between the main office, corner of Broadway and Dey-street, to No. 14, Broad-street office. Two tubes will also be laid from the main office to 134, Pearl-street, and the Cotton Exchange offices.

The pneumatic tubes will be of brass, which has been decided upon as preferable to lead or iron for this purpose. The carrier is a gutta percha pouch or box, covered with felt, two inches in diameter, with a band of felt projecting around the ends. Each carrier has a capacity for 50 messages, which are kept in place by a rubber band.

Duplex engines (working both by compressed and exhaust air) are to be used to force the boxes through the tubes, by means of which boxes will be sent in alternate directions through the pipes. The pistons of the pumps have an internal diameter of over two feet.

Subterranean wires will also be laid over the same routes, in cast iron pipes three inches in diameter, and which will be capable of containing 125 wires each.

The work is being carried out under the superintendence of Mr. George B. Prescott, the electrician to the Company, who came to Europe two years ago to examine the various systems employed in England and the Continent.

M. Chutaux has exhibited at 99, Boulevard Central Brussels, a magneto-electric-motor machine which he has patented, and of which the arrangement is simple and analogous to that of Froment.

Two wheels fixed on the same horizontal axle, and carrying on their periphery soft iron armatures are placed above two electro-magnets in each of which the current is alternately sent by means of a commutator. The electro-magnets are so placed that when one of the electro-magnets attracts an armature by the movement of the wheels, the second electro-magnet is brought into play and a continuous rotation of the wheels is produced, from the axle of which the motion can be carried to small machines, such as lathes, sewing machines, &c.

Mr. Chutaux has also applied his machine to electro-plating and other use. He has also in some machines increased the number of electro-magnets.—*Moniteur Industirel Bélge.*

An experimental trial of a new torpedo boat, embodying the most recent improvements of the Lay system, was recently tried near the Navy Yard, Washington, D.C. The boat, of cigar shape, 16 feet long, 19 inches in diameter, is made of iron. It is propelled by liquid carbonic acid, carried in a reservoir within the shell, the liquid being allowed to expand into gas, which operates an engine and propeller. The boat is steered and the speed and direction of the engine governed by electricity, the circuit being opened and closed by means of a cable, which is wound or unwound, as desired, from a reel carried in the boat; the boat's direction and motions being governed by electric keys, located at the station or on the vessel whence the torpedo boat is sent out. The boat carries an explosive magazine which is discharged by electricity.

To the Lay torpedo boat may be attached a line of floating explosive mines, connected with the operator's station, as is the torpedo itself, by electric cable. The torpedo boat may be despatched with these floating mines in tow to open the channel. The mines can be detached from the boat at any given point and sunk in position by an arrangement peculiar to their construction still retaining their electric cable connection with the operator's station. They may be fixed at will. Mr. Lay has invented a submarine torpedo battery for harbour and coast defence. It is similar to the ship floating torpedo.—*Scientific American.*

Since the successful opening of telegraphic communication between New South Wales and New Zealand, Western Australia has become the only member of the Australasian group of colonies not participating in the benefits of the South Australasian telegraphic system. A wire is, however, in course of erection between Adelaide and Perth, Western Australia, and this will complete the overland system of Australian telegraphs for the present.—*Engineering.*

The annual report of the Atlantic and Pacific Telegraphic Company shows that the receipts from messages were 386,826 dols., and the operating expenses, including supplies and line materials for repairs 396,399 dols., leaving a defict of 9,572 dols. The gain in receipts over 1874 was 24,545 dols., notwithstanding the loss of signal office patronage, the southern connection, and the reduction in rates. The increase in expenses is accounted for by the extensive and necessary repairs of lines. During the year 471 miles of poles and 1,466 miles of wire were put up.

We learn by telegram that the Turkish Government has forbidden the transmission of telegrams in cipher over their telegraph lines.—*Railway News.*

In a circular issued by the directors of the Direct United States Cable Company, they men-

tion the following particulars concerning their traffic during the interruption on the Anglo-American system:—

"The rush of traffic over the "Direct" cable practically lasted from the 4th to the 9th of May, inclusive, during which time 83,141 words were actually transmitted over the line. On the two heaviest days—viz., the 5th and the 9th of May—14,402 words and 15,906 words were sent over the line during each day, making an average speed for the whole of the 24 hours of 10 and 11 words respectively (the highest speed reached was 18 words per minute).

This speed, it must be borne in mind, was attained over the longest section of the system, viz., the main cable of 2,500 nautical miles.

On the shortest section of the line the speed was, of course, very much higher.

Considering the fact that the work usually performed by five cables was done during this time by one, it is a matter for congratulation that the maximum delay reached no more than about 15 hours, and that only at the time of the greatest pressure."

With regard to the interruptions in the Anglo-American system between Newfoundland and America, *The Telegrapher* of May 6th states: "This week all the other cables of the Anglo-American Telegraph Company are interrupted between the Island of St. Pierre and Placentia Bay, Newfoundland, which cuts off all communication between the cables which land at Heart's Content, N. F., and the connections this side, entirely suspending business.

"As the break is on the short section between Nova Scotia and Newfoundland, it will not probably take long to repair it. Unfortunately, the *Minia*, the regular repairing steamer of the Anglo-American Company, is at present on the other side of the ocean; but, another, a small boat, which has occasionally been engaged for repairing purposes, will be chartered, if possible, for the emergency."

The Telegrapher of May 13th, says: "The cable from Placentia Bay to Heart's Content, Newfoundland, is broken, and two of the cables connecting St. Pierre and Sydney, and four connecting Sydney and Placentia have been broken during the last two weeks, and now only one of them is in operation."

And in another paragraph, in their number of the same date, "the Anglo-American Company had one cable between St. Pierre and Placentia sufficiently repaired to resume the transmission of messages. The repairs of this cable not having been completed, communication was again interrupted Sunday night, and communication suspended until Tuesday noon. It is expected that the vessel employed will proceed to raise and repair the other cables, and it is supposed that within a brief time, perhaps before this paper reaches the reader, communication by the Anglo-American lines will be fully restored."

The Shanghai-Amoy section of the Great Northern Telegraph Company was broken on the 9th of May.

The Canadian Pacific Telegraph is now working as far as Battle River, some 600 miles west of Fort Garry.

Parliamentary Intelligence.

Major-General Symons, Inspector-General of Fortifications, gave evidence before the select committee of the House of Commons, on Post Office telegraphs on May 12. Alluding to the expedition against the Ashantees, he said that if it had not been for the assistance of telegraphs that war could not have been carried on. There ought to be, in his opinion, a number of men kept constantly in work as telegraphists, who could be called upon to perform the work of telegraphy for the army in the event of war.

Colonel Alexander: In the event of an invasion would civilians be as competent as soldiers to work the telegraphs in the vicinity of a hostile force?

Witness doubted it. He should be very much afraid of employing an undisciplined force in time of war if any hardships were expected.

Major Webber, C.E., a divisional engineer in the employment of the Post Office, give similar evidence, and the committee again adjourned.

In the House of Commons, on May 13th, Mr. Lowther, in reply to Mr. M'Arthur, said the subject of direct Telegraphic commnuication with Cape Colony and Natal, was now engaging the attention of the Colonial Office.

Proceedings of Societies.

PHYSICAL SOCIETY.—13th May, 1876.

Professor G. C. Foster, President in the chair.

The following candidates were elected members of the Society:—Professor T. Andrews, LL.D., F.R.S., Rev. R. H. M. Bosanquet, M.A., and David Howard.

Mr. Thompson, B.A., B.Sc., concluded the communication on the supposed New Force, which he commenced at the last meeting of the Society. In the arrangement which he has adopted for obtaining the spark, the secondary current of a Rhumkorff's coil is made to traverse a short coil of wire, which is thoroughly insulated from the internal coil, and into the circuit an arrangement is introduced by means ot which the spark may be made

to traverse a variable thickness of air in its course round the short coil. It is found that if this spark is very short the spark obtained from the internal coil is also short, but as we increase the thickness of air to be traversed, the spark which may be drawn off increases; the greatest effect, however, is produced when one terminal of the coil is connected with the earth, the spark then obtained being about half an inch in diameter. Mr. Edison considered that the spark was retro-active, but Mr. Thompson showed by an experiment that deficient insulation might lead to such a conclusion. He then proceeded to show that just as the charge given to a gold-leaf electroscope is at times positive and at times negative, without any apparent reason for the change, so if the core of the arrangement employed be connected with a Thomson's galvanometer, the needle will be found to wander irregularly about the scale on both sides of the zero. In order to show that these experiments are identical with those conducted as originally described by the discoverers, the terminals of the induction coil were connected with the coils of an electro-magnet, the same means of including a layer of air in the circuit being introduced. The effect in this case was found to be precisely similar to that obtained with the special arrangement previously used. With a brush discharge, a Geissler's tube could be illuminated, and, when the layer of air was infinitesimal, the spark produced was also infinitesimal. It was then shown that, if the spark at the point of contact in the key, when a direct battery current traverses the coil, be done away with, by shunting the extra current which gives rise to it, no spark can be obtained from the core. It thus appears that no spark is obtained when there is no necessity for an inducing current to accumulate until it has sufficient tension to leap over a resisting medium, and that, as the thickness of this resisting medium increases, the spark obtained becomes greater. Evidently on these occasions the charge has time to attract unlike and repel like electricity in the core, and, if a conductor in connection with the earth be presented to this core, the like electricity will escape; hence a spark will result. As soon, however, as the tension has become sufficient to leap over the layer of air, it will be necessary to restore equilibrium in the core. Hence there will be a return spark in the opposite direction. From these experiments it will be seen that the phenomena observed may be explained by the ordinary laws of induction.

Electrical Science in Foreign Journals.

Annales Télégraphiques. Vol. ii. Nov.–Dec., 1875.

The Life and Labours of Sir Charles Wheatstone. By M. E. Mercadier.

Comparison of the Batteries used in Telegraphy. A paper by M. Gaugain upon the different forms of battery known as the Daniell, Calland, Marié-Davy, and Leclanché.

A translation will be given in a future number.

The Pneumatic Telegraph. A description of the pneumatic telegraph system as established in Paris. This article is illustrated by three well-executed maps, showing the routes of the various tubes, stations, &c.

The Electric Anemometer of M. Hardy. By M. Gillet. This paper is translated in the present number.

Report upon the Direct United States Cable. A translation of the report made by Sir William Thomson upon the tests carried out by him at Ballenskellig's Bay on the 16th and 17th September, 1875. (In the title the year is incorrectly printed as 1874.)

Upon the use of the Induction Spark and of Electro-Magnets in connection with Electric Chronographs. By M. Marcel Deprez.

Having had occasion to examine the different methods of registering, by means of electricity, the successive stages of a very rapid operation, such as the passage of a projectile along the interior of a cannon, the author has made a comparative investigation of the various plans adopted in such cases. These methods are based upon three different properties of electric currents—the magnetisation of soft iron, electro-chemical decomposition, and the production of sparks by means of induction currents.

The first electric chronographs of Wheatstone, Constantinoff, &c., depended upon the use of electro-magnets which, upon electric contact being made, pressed a style against a blackened cylinder. In the chronoscope of Navez, Le Boulenge's, &c., the effect is produced upon contact being broken. The objections to the use of electro-magnets as hitherto employed are—the residual magnetism, the slowness of their demagnetisation, and especially of their magnetisation, and the consequent retardation in their action varying with the strength of the current. Finally, the slow motion of the cylinders would not permit the registration of such extremely short intervals of time as are involved in gunnery experiments.

The passage of a current through an iron style pressing upon paper moistened with cyanide of potassium produces a blue mark, which ceases with the interruption of the current; but this mode of recording has the objection of requiring a current of high tension and the keeping of the paper in a uniform state of moisture. The style also accumulates a little colouring matter which continues to mark the paper even after the current has ceased. These objections have led to the abandonment of the electro-chemical process as applied to chronographs.

The induction spark discharged against a silvered cylinder coated with lamp-black produces a spot in the centre of which is a very fine and distinct point. The retardation is less than one-ten-thousandth of a second, and with a very short distance between point and cylinder is quite unappreciable; but as the spark follows the route, which is *electrically* the shortest, deviations which cannot be neglected are the result.

Another difficulty is, that the spark is often followed by a train of minor sparks; and thus, in measuring a very short interval by two successive discharges from the same wire, the second spark may be confounded with the minor sparks of the first discharge. These difficulties become of even greater moment when the cylinder is covered with a sheet of blackened paper, provided for the registration of the experiments.

As already stated, the retardation of the spark is generally less than one-ten-thousandth of a second; but this does not mean that 10,000 sparks per second can be produced, for the time during which the primary circuit must be closed is much more than the above interval. In making 250 contacts per second with three Bunsen cells 250 sparks have been obtained, but they have been very small, and this number per second could probably not be much exceeded without great increase of battery power. To obtain sparks with an interval of one-ten-thousandth of a second would need an extremely powerful battery. For this reason experimenters who wish to record, by the induction spark, very rapid phenomena have used as many coils as there were signals to be obtained. In Captain Noble's chronograph eight coils, each with separate battery, are employed, each coil giving a separate signal as the projectile passes from point to point in the gun. It should be observed that the production of the spark is a capricious phenomenon, depending much upon the way in which contact is broken.

(*To be continued.*)

Correspondence.

To the Editor of the TELEGRAPHIC JOURNAL.

MR. EDITOR,—I read in an article by Mr. C. V. Walker, "On the work value of electro-magnets enclosed in iron," inserted in your number of the 15th May, that these sort of electro-magnets, which have a greater force than others, although of smaller volume, are of recent invention, and have never been described in any known work. It is stated in support of this, that in my work on the construction of electro-magnets, I have established that if a straight electro-magnet is enveloped in an iron tube, the internal core will be strongly magnetised, *but that the exterior envelope of iron will not be magnetised at all.*

If I rightly construed the thoughts of the author in this quotation, he has wished to demonstrate by this that I did not suspect the power of electro-magnets combined in this manner, and that, in consequence, the electro-magnets which he describes are really new.

Permit me to observe that there is a misunderstanding in the interpretation which Mr. Walker has given to this passage from my work, *which refers to two insulated magnetic limbs non-combined.*

In the experiments which I made on this subject, I wished to demonstrate that an electro-magnetic helix does not re-act externally on a cylinder of iron which envelopes it, and that it can only develope magnetisation when the iron is enveloped by it.

In every case, if this species of iron casing* is magnetically bound to an iron core enveloped by the helix it is no longer the same; for this casing takes the polarity of the iron core with which it is in contact, and constitutes thus *a two branch electro-magnet, one of which branches gives an annular pole, and the other a central pole enveloped by the first.*

This system of electro-magnet, which in France has received the name of *tubular electro-magnet*, was invented by Mr. Nicklès about 1852, and I have described it in all my works; for example, in the various editions of my work, *Exposé des applications de l'Electricité* (the first appeared in 1873), in my *Etude sur le Magnetisme*, etc.

This electro-magnet has very great power, and allows of energetic action with a very small armature. Moreover, it has been employed in a great number of electrical instruments. Mr. Wartmann used it in 1855 for his automatic regulator of strength of currents; Mr. Bonelli had even applied it to his electric loom; Messrs. Fàbre and Kunemann, to electro-motors; Messrs. Hardy and Dugan, to an electric tell-tale for indicating the extinction of night signals on railways, etc. It was these electro-magnets which led Mr. Nicklès to invent circular electro-magnets, which were applied to locomotive wheels to increase adhesion to the rails.

These electro-magnets are in fact only double tubular electro-magnets. Suppose a bar of iron terminated at its two extremities by two discs of iron, and that between these discs is wound the magnetic helix, you will have a straight electro-magnet, of which the two poles will be represented by the discs. Suppose, now, that to these discs are soldered two iron cylinders, directed one towards the other so as to envelop the helix, and leave between them only an interval of a few millimetres, you will have an iron cylinder cut in two in the middle, and each half of this cylinder will have a different pole; consequently, if you make this cylinder roll on an iron rail in such a manner that the separation of the two cylindrical casings corresponds with the middle of the rails, you will have an electro-magnet which in revolving will act constantly on the rail at its two poles, and under favourable conditions for so acting.

Again, these circular electro-magnets have been applied to transmit motion in place of spur gearing. For this it is only necessary to replace the rail previously in question by an iron cylinder, of which the axle is parallel to that of the circular electro-magnet.

The question, you perceive, has been much more studied than you believe in England, and you can see in the work of Mr. Nicklès on electro-magnets, as well as in the second volume of my *Exposé des applications de l'Electricité* (3rd edition), all the forms of electro-magnets and of electro-magnetic systems which have been hitherto invented.

I beg you to accept, &c., &c.,

TH. DU MONCEL,
Member de l'Institute de France

PARIS, *May* 17.

ANSWERS TO CORRESPONDENTS.

AMATEUR.—"Experiments with the new force," by George M. Beard (reprinted from the archives of Electricity and Neurology, November, 1875), is Published by T. L. Clacher, 107, Twenty-eighth Street, New York.

W. CRAWFORD.—Received. Will appear with answer in our next.

* Mr. Du Moncel uses the term "chemise."